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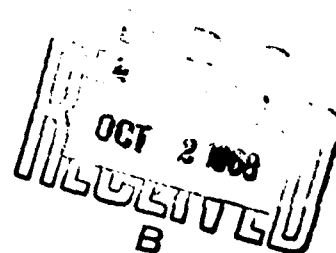
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SOME NEW PROCEDURES FOR THE IDENTIFICATION OF ANIMALS AND
THE USE OF PUNCH CARDS IN THE WORK OF THE ZOOLOGIST

/Following is the translation of an article by P. A. Reznik,
Stavropolskiy Teaching Institute, published in the Russian-
language periodical Zoologicheskiy Zhurnal (Zoological Journal)
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by Sp/7 Charles T. Ostertag, Jr./

The initial phase of every botanical and zoological investigation is establishing the species affiliation of the object being studied. The rapid and unconditionally correct performance of this part of the work is of decisive significance.

Due to the many-yearred efforts of taxonomists, modern dichotomous tables have been developed which are used with insignificant variation by both botanists and zoologists. The number of advantages of this method of establishing the name of an animal or plant was the reason the dichotomous tables became international. All work on improving the method of identification using this process essentially amounts to only a more successful selection of taxonomic criteria, the principle of compiling the tables remains unchanged for many years already.

Naturally the dichotomous tables possess numerous advantages which give them such a wide popularity, however, this does not exclude the feasibility of searching for other methods for identifying living organisms. In this connection attention is directed to the series of articles by B. Ye. Balkovskiy, published in 1962 in the "Botanicheskiy Zhurnal" (No. 1, 6, 11). In particular, he recommended a somewhat different principle for compiling the keys. B. Ye. Balkovskiy calls it the polytomic principle and points out that it is devoid of many deficiencies inherent to the dichotomous tables.*

*While this article was at the editorial office it became known to us that the "Index of Pests and Diseases of the Grape" by P. Kh. Kiskin (Kishinev, 1964) came off the press. It is based on the polytomic method, using punch cards.

As an example, when working with the existing tables an error in any one point amounts to the fact that further work in identification goes on in vain, since the error may not be ascertained right up to the end of the identification. In polytomic tables such an accumulation of errors does not take place. When using the dichotomous tables the object may remain unidentified if a feature, necessary during the course of the identification, is missing. Polytomic tables are devoid of this deficiency.

Polytomic tables not only ease the process of identification, but are also more convenient for compilation. As an example, in the table it is possible to add any new features or, conversely, discard some of them, since here the position of one feature does not determine the position of another. In these tables each feature is independent. Further, in these tables the objects are easily arranged in accordance with their systematic position, which is often very difficult to do when compiling dichotomous tables.

How then are the polytomic tables constructed? Each table consists of two parts. In the first of these there is a list of systematic features, which are combined in so-called series. Each such series contains features characterizing some organ or body part. The series are numbered with Roman numerals, and the features included in them - with Arabic.

The initial phase in the identification amounts to an examination of those parts of the body which are designated in the series, and as a result of this examination the peculiarities of their structure are established. The result of this work should be a record, consisting of paired figures. The first of these is the number of the series, the second is the number of that feature which is possessed by the certain part of the animal's body.

After this there is a shift to the second part of the table. It is a series of columns, the first of which contains the list of systematic groups subject to identification. The following columns bear the numerical designations of the above mentioned series (I, II, III, IV, etc.). At the points of intersection of the rows corresponding to the systematic groups and the columns with the numerical series there is the figure indicating that the given group of animals possesses that feature which in the corresponding series comes under this same number (in the first part of the table).

The identification process amounts to the selection, in the second table, of that combination of Arabic figures which ended up being recorded as the result of the preliminary examination of the animal. In many cases it is not necessary at all to have data on all the organs of the animal. It may be sufficient to have only part of the features present for an identification. It is necessary to strive for this in compiling the determinative tables for this genus.

Stemming from this method, we have compiled identification tables for all the groups of Ixodes ticks from our fauna. Following we present a sample table for the identification of genera of this subfamily.

Accessory Table for Identifying Genera from the Subfamily Ixodinae

Series I. Anal groove

- indistinct 1
- groove present, rounding the anus in front 2
- groove present, rounding the anus from behind. 3
- groove present; in the form of two parallel grooves, it is
disposed behind the anus 4

Series II. Eyes

- eyes absent. 1
- eyes flat 2
- eyes hemispherical 3

Series III. Anal scutellum of the males

- scutella indistinct. 1
- scutella disposed only in the rear part of the body. 2
- ventral surface of body covered almost solidly with shield,
divided into the individual sectors. 3

Series IV. White pigment of the scutellum

- pigment absent 1
- pigment present 2

Series V. Anal setae

- setae disposed in one row along the middle commissure 1
- setae disposed in one row parallel to the outer edge of the
folds of the anal valve. 2
- setae disposed in two rows - one along the middle commissure,
the other - parallel to the edge of the folds. 3

The above described polytomic tables may be improved by transferring the data from these tables to perforated index cards.

The standard perforated index card has the dimensions of 187 x 82 mm. The card contains 9 short lines, consisting of repeating identical numbers from one (at the top) to 9. These short lines have the name "positions". Above the figure one is a short line made up of zeroes - this is the 10th position, and still higher - a border, free from numbers, on which still two more positions can be placed - the 11th and 12th. Above the line with the zeroes and below the line with the eights there are lines with numbers from 1 to 45. These are the numbers of the columns. There are cards with 80 columns, with the same card dimensions, but for our work the 45-column cards are sufficient. The upper left corner of the card is cut away. This is done so that it is possible to detect any cards which are reversed in the trough.

Perforated index cards are used in certain modern calculators, but in the practical work of the zoologist-taxonomist it is possible to use simplified perforated index cards without complex machines.

Using a special perforator round holes are punched in specific places on the cards. We recommend the following placement for the holes: In the 1st and 45th columns the holes are punched in the 1st-8th and 10th-11th positions. In the 9th and 12th positions the holes are punched in even numbered column. In this way the card is uniformly punched on all four sides. On the short sides there are 10 holes each, above and below - 22 holes each, a total of 64 holes. It is not practical to punch holes in each column along the top and bottom, since in this case due to the close spacing of the holes the card may become weakened along the edge, and with frequent use the perforated index cards may break. For our purposes 64 holes are quite sufficient.

The holes can be punched out at organizations having perforator computing devices. Further processing of the cards is carried out by the investigator himself and it amounts to encoding, that is, transferring the specific material to the perforated index cards.

Each hole on the card can handle only one meaning and the card can answer a question concerning this meaning either positively ("yes") or negatively ("no"). If the card should give a positive answer, then a slit is made on the exterior of that hole. Cards with a meaning of "no" have intact holes. When the cards are stacked in the trough, then all the holes match rigidly. A metallic rod (for example, an office awl) is inserted in the necessary hole and the cards are raised a little. All the cards with the cut-out holes, that is, having the coded feature under question, separate out, and all the cards without it are hooked to the rod. This is how the cards are selected, based on any one feature. Then they can be divided again,

setting up the rod in other openings, corresponding to another property of the object being investigated. Finally, from the entire trough of cards it is possible to select those which possess the necessary combination of features, and, if it is necessary, to carry out this operation until there is only one card is separated. Such coding is called direct.

A second method of coding is called combination. In this method the feature is coded not with one hole, but with a specific combination of two holes. Thus, it is convenient to code figures. Any single-valued number can be viewed as the sum of one of the pairs of the following numbers: 0, 1, 2, 3, 7. In accordance with this, the values of these five figures are assigned to the holes. Combining them produces all the numbers from 1 to 9. With such a method of coding the holes on the cards are economized - instead of 9 only 5 are required. In order to speed up work with the cipher code two rods can be inserted into the appropriate holes at the same time. For coding two-digit numbers still five more holes are required for figures designating tens.

The so-called "pyramid" code is used for ciphering letters. With its help the entire alphabet can be encoded on eight holes. The drawing shows how this code works. Each letter has an "outlet" to two holes and the combination of each pair corresponds to only a specific letter. Consequently, two appropriate grooves will designate a specific letter. This code can be worked conveniently with the help of two rods.

Now we will shift directly to the material of our article. First of all we will code those features which are used to identify genera of ticks. For this we do not require a large number of holes and it can be done more conveniently on the lateral sides of the card.

As a basis we will use the previously cited polytomic table. The first four openings to the left (11th, 10th, 1st and 2nd positions) are coded for the features of the first series (structure of the anal groove). For the second series we set aside the 3rd, 4th, and 5th positions. On the remaining three holes (6th, 7th, and 8th) we encode the peculiarities in the structure of the anal scutellum. On the right, in the same manner, we encode the features of the IV series (11th and 10th positions) and the V series (1st, 2nd, and 3rd positions). The remaining rows (4-9th) remain unused. If desired, certain additional features can be encoded on them.

The holes of which positions turn out to be grooved for the various genera as a result of such a coding?

Ixodes	left - 10, 3, 8;	right - 11, 1
Ceratixodes	left - 2, 3, 8;	right - 11, 1
Haemaphysalis	left - 1, 3, 6;	right - 11, 2
Boophilus	left - 11, 4, 7;	right - 11, 2
Dermacentor	left - 1, 4, 6;	right - 10, 3
Rhipicephalus	left - 1, 4, 7;	right - 11, 3
Hyalomma	left - 1, 5, 7;	right - 11, 3

On the cards with the appropriate code the name of the genus is written.

Deciphering the code can be done on a separate sheet in such a form:

Series L. Anal groove

. . . indistinct position 11, left
. . . rounding anus in front position 10, left
. . . rounding anus from behind. . . position 1, left

etc.

But this may be done differently. A clean index card with perforated holes is taken and turned so that the cut corner is found at the top right. On this clean side a vertical line is made, dividing the card in half. On the left and right against the corresponding holes the features are written. They may be abbreviated. The series are divided by horizontal lines. Such a card considerably eases the operation and therefore the identification can begin with any series, using initially the most clearly expressed peculiarities of structure. Thus, it is possible that the necessary card will be separated out on the second or third, and possibly the first time.

The principle for identifying species remains the same. For coding we use the upper (for males) or lower (for females) rows of holes. Further, on the card the name of the species is placed and enciphering of the code is worked out. Just as in the previous case, it can be done on the card, but making the entries on it at right angles. Two cases are possible here: If the entries are made on the reverse side of the card then two cards should be used - one for males and the other for females. It is possible to do it this way: The features of the males are placed on the face side, and the features of the females - on the reverse side of the index card.

It is possible to separate out the cards with the generic features and place the appropriate code directly on the species cards. In such a case identification should begin with the entire pack of 50 cards, which naturally slows down the first phase of the work - identification of the genus.

On the rear clean sides of the cards the appropriate features, characterizing the given genus or species, and drawings are placed.

It is very possible that at first sight it may seem that working with the perforated index cards is more complex than identification with the help of dichotomous tables. But the first use of perforated index cards will show the advantages of this method. We think that the time will arrive when instead of the usual identifier's, packs of perforated index cards with the appropriate coding for all the features will be issued. On auxiliary cards to them will be the deciphering of all the codes. It is understandable that in this case it will be more convenient to use somewhat changed cards - their central portion will be free of numbers and all the necessary information placed on it.

Our method of using perforated index cards does not demand the use of machines (except the perforator for punching out the holes). But with the development of electronic devices and the appearance of complex calculators in each institution, work with the perforated index cards will be eased all the more. In this case coding will take on a somewhat different form. The entire series of features will be disposed in one column and the number of the position will correspond to the ordinal number of the feature in the given series. Thus, on one card it will be possible to encode an index for an entire subfamily of Ixodes ticks. Searching out the necessary card will be performed with an ordinary sorting machine and will take only a few minutes.

In conclusion it is necessary to point out still another use for perforated index cards - the transferring of bibliographic data to them.

Printed work in any branch of science is being put out in quantities which are increasing yearly. To keep track of all the literature, even on a particular problem, and the more so to keep it in mind, is becoming quite impossible. Even on such a small group of animals as the Ixodes ticks the native bibliography alone contains more than a thousand entries, and this number is increasing yearly by several hundred publications.

Every investigator has a more or less comprehensive card file on the branch of knowledge which interests him. What data are contained on the cards? Usually all the information found on the cards amounts to the name of the author, the name of the work, and the year of publication. Such cards do not reflect the contents of the article at all, and this must be kept in memory or recorded separately. This can be helped to some degree by annotated indexes, but they suffer from at least two deficiencies. First of all they are already old when they are published and it cannot be calculated they will be regularly supplemented with data on newly published literature. The second and most significant deficiency is that they can orient investigators only weakly in that sea of articles which is being published yearly. In annotated lists the dissemination of papers based on division is very poor, since most often of all each paper contains diverse information - on the distribution, biology, and practical importance on the animal, and it is necessary that each article be listed in the various sections of the index, which is just about impractical, or the paper is placed in only one place in the catalogue and, consequently, all the other problems dealt with in the article remain unexposed. This and other things create a difficulty both in compiling and in using such annotated indexes.

All of these difficulties are removed easily if all the information is transferred to perforated index cards. As an example, we will cite the coding of a perforated index card relative to native literature on Ixodes ticks.

With what information and in what way is it possible to encode the perforated index cards? For this we will use the same card with the same initial holes as when coding the identifier.

It is most expedient to code the species name with a numerical code. A list of species is compiled and each of them has its own specific ordinal number. Several numbers are left empty at the end of the list of species of each genus. These are left for species which will possibly be described or discovered later on. The number of "empty" numbers can be different for different genera. As an example, without a doubt for the genus *Ixodes* it is necessary to leave more numbers than, shall we say, for the genus *Dermacentor*. For coding the species 10 holes are set aside in Column No. 1. In positions 8-4 the tens are ciphered, and in positions 3-11 - units of numbers, designating the ordinal number of the tick (position 8 has the value of zero, position 7 - units, etc.).

The author is encoded above at the beginning. The first letters of the family name and the given name are coded. In the overwhelming majority of cases this is sufficient for separating out the cards which interest us. Ciphering of these data occupies 16 columns. The family name will be encoded in columns 2-16, and columns 18-32 will contain the initial letter of the author's given name.

Then the year of publication is ciphered. For this it is completely sufficient to encode the last two figures - in the last century papers on the *Ixodes* ticks appeared only at the end of the century and therefore the century cannot be shifted (remember, we are talking about native literature). It is more convenient to do this from the right side of the card, in column 45, since positions 8-4 will designate tens, and 3-11 - units of the number designating the year of publication.

On the lower side we place: Papers on the systematic system and new descriptions (column 2), on morphology and physiology (column 4), data on pre-imago phases (6), ecological material (8), zoogeography (10), data on parasites of ticks (12), the pathogenic significance of their bites (14), ticks as carriers of viruses, rickettsiae, bacteria and Protozoa (columns 16-22 correspondingly), and combatting ticks (column 24).

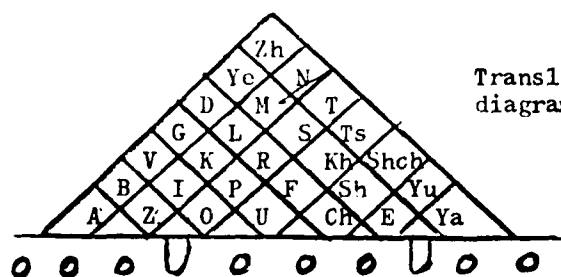
Further it is possible to designate papers on ticks from various places of the Soviet Union. It is possible to set aside such regions: The north, center of the European part and the Preibaltic (column 26), the Ukraine and Moldavia (28), the south of the European part and the Predkavkaz (30), Kavkaz and Zakavkaz (32), Western Siberia and the Urals (34), Kazakhstan (36), the republics of central Asia (38), Central and Eastern Siberia (40), the Far East and the Maritime Provinces (42). The last hole remains free and may be used for coding any particular problem which interests the investigator.

In the 12th position six holes still remain free. They may be used for the following values: Composite works on ticks (column 34), identifiers (36), methods for studying ticks (38), materials from meetings and conferences (40), study of natural focalness (42), other papers - bibliographies, history, personnel, etc. (44).

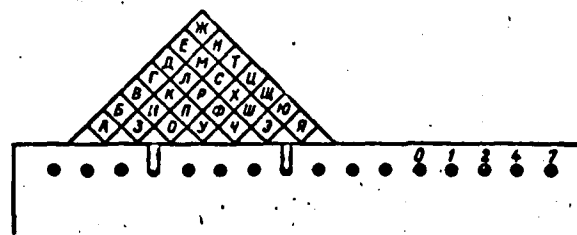
In the center of the card there is information from the usual catalogues, and on the reverse side - a brief annotation of the paper.

With the help of such cards, literally with one movement it is possible to select from the pack all the cards containing problems which interest us. It is possible to remove papers, belonging to such an author, containing information about ticks from a certain region, published in such a year, or papers in which certain species are mentioned. After the cards have been used it is not necessary that they be laid out in a specific order, they may lie in the pack in any sequence. No other method is capable of facilitating this work to the same degree as working with perforated index cards. It is desirable to create a card index for foreign literature also, coding the papers, by language, geographical regions, authors, etc. We like to believe that the time is not far away when similar perforated index cards do not have to be made by the investigator himself. They will be published commercially and some organization, for example - the All-Union Institute of Scientific and Technical Information, will encode all the newly published literature and distribute it to its permanent subscribers. In this manner a very important result is achieved - each specialist, in the shortest period of time, will obtain all the necessary information.

The accumulation of a huge amount of material in any branch of science does not yield to treatment by old methods. It is very necessary to revise our usual methods, all the more so because already at the contemporary stage of development technology has the capability to do much in this respect.



Transliteration of the diagram below



"Pyramidal" code for coding letters.
For explanation, see text.

Identification Table

Genera	Series				
	I	II	III	IV	V
Ixodes	2	1	3	1	1
Ceratixodes	4	1	3	1	1
Haemaphysalis	3	1	1	1	2
Boophilus	1	2	2	1	2
Dermacentor	3	2	1	2	3
Rhipicephalus	3	2	2	1	3
Hyalomma	3	3	2	1	3